

SANITARY SEWER HORIZONTAL DIRECTIONAL DRILL

ITEM 17A

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. Scope of Work

This specification covers the requirements for furnishing all labor, equipment and materials associated with the installation of gravity or pressure sanitary sewer pipe by directional drilling method. The gravity sewer pipe may be fusible polyvinyl chloride (PVC) pipe, restrained joint PVC pipe, or fusible high density polyethylene (HDPE) pipe as specified herein.

This work shall include, but not be limited to, steerable directional boring equipment, boring pits and equipment, sheeting, maintenance of traffic and coordination with other Contractors, miscellaneous appurtenances to complete the work as shown on the contract drawings, cleanup and disposal of spoils, and restoration. Directional drilling operations shall be performed within the right of way and/or easements shown on the drawings.

B. The work specified herein shall include:

1. Excavation of drilling and receiving pits.
2. Potholing or other similar practices as required to verify underground utilities along the entry and exit drill paths.
3. Drilling of a pilot hole at prescribed line and grade.
4. Reaming of the hole (as needed).
5. Pullback of the pipe through the hole.
6. Pressure testing of the pipe.

7. Connect piping to manholes (as needed and shown of the drawings).
8. All incidental work such as horizontal and vertical control points, survey, grids, permits, slurry treatment and disposal, shoring and casing of the pits if required, including maintenance of traffic, and all else necessary for the complete installation of the pipe in accordance with these specifications and contract drawings.

1.02 QUALITY ASSURANCE

A. The requirements set forth in this document specify a wide range of procedural precautions necessary to insure that the very basic, essential aspects of a proper directional bore installation are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this specification. Adherence to the specifications contained herein, or the Engineer's approval of any aspect of any directional bore operation covered by this specification, shall in no way relieve the Contractor of their ultimate responsibility for the satisfactory completion of the work authorized under the Contract.

B. Standards.

1. Referenced Specifications

ANSI/AWWA C110/A21.10	American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-inch through 48- inch, for Water and Other Liquids
ANSI/AWWA C111/A21.11	American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C605	Standard for Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water

AWWA C900	Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 12 in., for Water Distribution
AWWA C905	Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in. through 48 in., for Water Distribution
AWWA C906	Polyethylene (PE) pressure Pipe & Fittings, 4 inch through 63 inch for water
AWWA M23	AWWA Manual of Supply Practices PVC Pipe - Design and Installation, Latest Edition
ASTM A167	Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM C923	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C1173	Standard Specification for Flexible Transition Couplings for Underground Piping Systems
ASTM D1238	Melt Flow Index
ASTM D1505	Density of Plastics
ASTM D1784	Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds
ASTM D1785	Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120 Test Method for Degree of Fusion of Extruded
ASTM D2152	Polyvinyl Chloride (PVC) Pipe and Molded and Fittings by Acetone Immersion
ASTM D2241	Polyvinyl Chloride (PVC) Plastic Pipe (SDR-PR)
ASTM D2665	Polyvinyl Chloride (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

ASTM D2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
ASTM D3035	Standard Spec for PE Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3139	Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3261	Butt Heat Fusion PE Fittings for PE Pipe & Tubing
ASTM D3350	Standard Specification for PE Pipe & Fittings Materials
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based On Outside Diameter
ASTM F1057	Standard Practice for Estimating the Quality of Extruded Polyvinyl (PVC) Pipe by the Heat Reversion Technique
NSF Std.#14	Plastic Piping Components & Related Materials

2. Manufacturer's Specifications

C. Contractor's Qualifications

1. Directional drilling Contractor shall have actively engaged in the installation of pipe using on-grade boring for a minimum of three (3) years. Evidence of qualification shall be submitted with Bid.
2. Field supervisory personnel employed by the directional drilling contractor shall have at least three (3) years experience in the performance of the work. Qualifications shall be submitted with Bid.

3. The County reserves the right to require an on-site representative of the directional drilling equipment manufacturer and/or a representative of the drilling fluids manufacturer, knowledgeable in the use of the product(s), for a minimum of two (2) working hours per work day (10 days maximum). The cost for the on-site representative(s) will be paid by the Contractor.

1.03 SUBMITTALS

A. WORK PLAN

Prior to beginning work, the Contractor must submit to the Engineer a general work plan outlining the procedure and schedule to be used to execute the project. Plan should document the thoughtful planning required to successfully complete the project.

B. EQUIPMENT

Contractor will submit specifications on directional drilling equipment to be used to ensure that the equipment will be adequate to complete the project.

C. MATERIALS

1. Specifications on material to be used shall be submitted to Engineer. Material shall include the pipe, fittings and any other item which is to be an installed component of the project.
2. The following Product Data is required from the pipe supplier and/or fusion provider:
 - a. Name of the pipe manufacturer and a list of the piping and quantities to be provided by manufacturer.
 - b. Product data and pipe supplier data indicating conformance with this specification and applicable standards,

including written documentation regarding any intended variance from this specification and applicable standards. This will include experience of pipe supplier by years and number of projects; warranty information; and independent laboratory testing certification.

- c. Material and pipe property testing in conformance with this specification and applicable standards indicating conformance from the pipe extruder per AWWA C900 and AWWA C905:

- 1) Dimensional Checks
- 2) Pipe Burst
- 3) Flattening
- 4) Extrusion Quality (Acetone Immersion)

- 3. Test results will be prepared and made available from the pipe extruder to the Owner or Engineer upon request, for each extrusion run.
- 4. As applicable, fusion joint data and fusion technician data indicating conformance with this specification and applicable standards, including written documentation regarding any intended variance from this specification and applicable standards. This will include fusion joint warranty information and recommended project specific fusion parameters, including criteria logged and recorded by data logger.

1.04 JOB CONDITIONS

A. Environmental Requirements

- 1. Drilling operations must not interfere with or endanger surface and activity upon the surface. Areas outside designated work areas should not be disturbed. Examine work area and notify Engineer of conditions that may adversely affect work.

2. Contractor shall conduct operations and schedule cleanup in a manner to cause the least possible obstruction and inconvenience to traffic, pedestrians and to adjacent property owners.

B. Safety. The Contractor shall carry out the operations in strict accordance with all applicable OSHA regulations.

1.05 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall take precautions to protect the pipe while being handled. Chain, end hooks, or cables slings shall not be used to handle pipe. Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe.

B. Care shall be taken to protect the pipe from scarring, gouging, or excessive abrasion. Pipe with gouges deeper than 10% of the minimum wall thickness will be rejected.

C. If pipe is stacked, stacking height shall not exceed the manufacturer's recommendations.

D. The Contractor shall comply with the Manufacturer's storage and handling requirements.

1.06 MANUFACTURER

A. Contractor shall use one of the following pipe materials for horizontal directional drilling installation.

B. Fusible PVC pipe shall be tested at the extrusion facility for properties required to meet all applicable parameters as outlined in AWWA C900, AWWA C905, and applicable sections of ASTM D2241. Testing priority shall be in conformance with AWWA C900 and AWWA C905. Fusible PVC pipe shall be manufactured under the trade names Fusible C-900, Fusible C-905, and FPVC, for Underground Solutions, Inc. Poway, CA, (858) 679-9551 or Engineer-approved equivalent.

- C. Restrained joint PVC pipe shall be manufactured only from water distribution pipe and couplings conforming to AWWA C900. The restrained joint system shall also meet all short and long term pressure test requirements of AWWA C900. Pipe, couplings, and locking splines shall be completely non-metallic to eliminate corrosion problems. Qualified manufacturer shall be C900/RJ PVC restrained joint pipe from CertainTeed Corporation, or Engineer-approved equivalent.
- D. All HDPE pipe and fittings shall be from a single manufacturer, who is fully experienced, reputable and qualified in the manufacture of the HDPE pipe to be furnished. The pipe shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications. Qualified manufacturers shall be: PLEXCO Division of Chevron Chemical Company, DRISCOPIPE as manufactured by Phillips Products Co., Inc., ISCO pipe as manufactured by ISCO Industries, SCLAIRPIPE as manufactured by Dupont of Canada or Engineer-approved equivalent.

1.07 WARRANTY

The pipe Manufacturer shall provide a warranty against manufacturing defects of material and workmanship for a period of ten years after the final acceptance of the project by the Owner. The Manufacturer shall replace at no expense to the Owner any defective pipe/fitting material including labor within the warranty period.

PART 2 MATERIALS

2.01 FUSIBLE PVC PIPE, JOINTS AND FITTINGS

- A. Fusible polyvinylchloride plastic material for pipe shall conform to AWWA C900 or C905, ASTM D1784, and cell classification 12454. Pipe shall have minimum dimension ratio DR18 and pressure class 235.

- B. Pipe shall be manufactured with 100% virgin resin. Pipe shall also have 0% recycled plastics content, and shall not consist of any rework compound, even that obtained from the manufacturer's own production using the same formulation.
- C. Fusible polyvinylchloride pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.
- D. Fusible polyvinylchloride pipe shall be manufactured in a standard 20', 30' or 40' nominal lengths.
- E. Fusible polyvinylchloride pipe shall be green in color.
- F. Pipe shall be marked per AWWA C900 or AWWA C905, and shall include as a minimum:
 - 1. Nominal size
 - 2. PVC
 - 3. Dimension Ratio, Standard Dimension Ratio or Schedule
 - 4. AWWA pressure class or rating
 - 5. AWWA Standard designation number
 - 6. Extrusion production-record code
 - 7. Trademark or trade name
 - 8. Cell Classification 12454 and/or PVC material designation code 1120 may also be included.
- G. Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other deleterious faults.
- H. Unless otherwise specified, fusible polyvinyl chloride pipe lengths shall be assembled in the field with butt-fused joints. The Contractor shall follow the pipe supplier's written instructions for this procedure. Joint strength shall be equal to the pipe as demonstrated by testing requirements. All fusion joints shall be completed as described in this specification.

I. The following connections are to be used in conjunction with tie-ins to other gravity sewer piping and structures, and shall be as indicated on the drawings or as directed by the Engineer.

1. PVC Gasketed, Push-On Couplings

- a. Acceptable couplings for joining fusible PVC pipe to other sections of fusible PVC pipe or other sections of PVC pipe shall include gasketed PVC, push-on type couplings.
- b. PVC gasketed, push-on fittings and/or retainer glands must be installed per the manufacturer's recommendations.

2. Sleeve-Type Couplings

- a. Sleeve-type mechanical couplings shall be manufactured for use with PVC pipe, and may be restrained or unrestrained as indicated on the drawings or as directed by the Engineer and in these specifications.
- b. Acceptable sleeve-type mechanical pipe couplings shall include for unrestrained coupling Smith-Blair Omni-Coupling, Dresser Style 253 or Long Style 253, or approved equal.
- c. Acceptable sleeve-type mechanical pipe couplings shall include for restrained coupling EBAA Iron Series 3800 or approved equal.

3. Expansion and Flexible Couplings

- a. Expansion-type mechanical couplings shall be manufactured for use with PVC pipe, and may be restrained or unrestrained as indicated on the drawings and in these specifications.

- b. Acceptable expansion-type mechanical pipe couplings shall include EBAA Iron EX-TEND 200, Smith-Blair Type-611 or Type-612, or approved equal.
- c. Acceptable flexible couplings shall include EBAA Iron FLEX-TEND or approved equal.

4. Connection Hardware

- a. Bolts and nuts for buried service shall be made of non-corrosive, high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21.11, regardless of any other protective coating.

J. Connection to Sanitary Sewer Manholes and Structures:

- 1. Fusible polyvinylchloride pipe shall be connected to manholes and other structures to provide a leak-free, properly graded flow into or out of the manhole or structure.
- 2. Connections to existing manholes and structures shall be as specified below or as directed by the Engineer.
 - a. For a cored or drilled, opening provide a flexible, watertight connection that meets and/or exceeds ASTM C923.
 - b. For a knock out opening, provide a watertight connection (waterstop or other method) meeting the material requirements of ASTM C923 that is securely attached to the pipe with stainless steel bands or other means.
 - c. Grout opening in manhole wall with non-shrink grout. Pour concrete collar around pipe and outside manhole opening. Provide flexible pipe joint or flexible connector within 2' of collar.

3. Connections to a new manhole or structure shall be as specified below or as directed by the Engineer.
 - a. A flexible, watertight gasket per ASTM C923 shall be cast integrally with riser section(s) for all precast manhole and structures.
 - b. Drop connections shall be required where shown on drawings.
 - c. Grout internal joint space with non-shrink grout.

K. Fusion Process

1. General

- a. Fusible polyvinylchloride pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe supplier's recommendations.
- b. Fusible polyvinylchloride pipe will be fused by qualified fusion technicians, as documented by the pipe supplier. Training records for qualified fusion technicians shall be available to the Engineer upon request.
- c. Each joint fusion shall be recorded and logged by an electronic monitoring device (data logger) affixed to the fusion machine. Joint data shall be submitted as part of the As-Recorded information, in accordance with this specification.
- d. The fusible polyvinylchloride pipe will be installed in a manner so as not to exceed the recommended bending radius.

- e. Where fusible polyvinylchloride pipe is installed by pulling in tension, the recommended Safe Pulling Force, according to the pipe supplier, will not be exceeded.
- f. Only appropriately sized, and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. Fusion machines must incorporate the following properties, including the following elements:
 - 1) HEAT PLATE - Heat plates shall be in good condition with no deep gouges or scratches within the pipe circle being fused. Plates shall be clean and free of any contamination. Heater controls shall properly function, and cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, per the pipe supplier's recommendations.
 - 2) CARRIAGE - Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.
 - 3) GENERAL MACHINE - Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion.

- 4) DATA LOGGER - The current version of the pipe supplier's recommended and compatible software shall be used. Protective case shall be utilized for the hand held wireless portion of the unit. Datalogger operations and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.

g. Other equipment specifically required for the fusion process shall include the following:

- 1) Pipe rollers shall be used for support of pipe to either side of the machine
- 2) A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement and /or windy weather.
- 3) Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.
- 4) Facing blades specifically designed for cutting fusible polyvinylchloride pipe.

L. Joint Recording

Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the fusion of fusible polyvinylchloride pipe. The software shall include fusible polyvinylchloride pipe

based dimensional data and fusible polyvinylchloride pipe based interfacial pressure relationships. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.

2.02 PVC RESTRAINED JOINT PIPE AND FITTINGS

- A. Products delivered under this specification shall be manufactured only from water distribution pipe and couplings conforming to AWWA C900. The restrained joint pipe system shall also meet all short and long term pressure test requirements of AWWA C900. Pipe, couplings, and locking splines shall be completely non-metallic to eliminate corrosion problems.
- B. Pipe and couplings shall be made from unplasticized PVC compounds having a minimum cell classification of 12454, as defined in ASTM D1784. The compound shall qualify for a Hydrostatic Design Basis (HDB) of 4000 psi for water at 73.4°F, in accordance with the requirements of ASTM D2837.
- C. Restrained joint PVC pipe products shall have been tested and approved by Underwriters Laboratories for continuous use at rated pressures. Copies of agency approval reports or product listings shall be provided to the Engineer. Products intended for contact with potable water shall be evaluated, tested, and certified for conformance with NSF 61 by an acceptable certifying organization.
- D. Nominal outside diameters and wall thicknesses of restrained joint pipe shall conform to the requirements of AWWA C900. Restrained joint pipe shall be furnished in 4", 6", 8", 10" and 12" sizes, in pressure class 235 (dimension ratio DR18) and pressure class 305 (dimension ratio DR14). Pipe shall be furnished in standard lengths of 20 feet.

E. Joints

1. Pipe shall be joined using non-metallic couplings to form an integral system for maximum reliability and interchangeability. High-strength, flexible thermoplastic splines shall be inserted into mating, precision machined grooves in the pipe and coupling to provide full 360° restraint with evenly distributed loading.
2. Couplings shall be designed for use at or above the pressure class of the pipe with which they are utilized, and shall incorporate twin elastomeric sealing gaskets meeting the requirements of ASTM F477. Joints shall be designed to meet the zero leakage test requirements of ASTM D3139.

F. Pipe and couplings shall be homogeneous throughout and free from voids, cracks, inclusions and other defects, and shall be as uniform as commercially practicable in color, density and other physical characteristics.

G. Every pipe and machined coupling shall pass the AWWA C900 hydrostatic proof test requirements of 4 times the pressure class for 5 seconds.

H. Pipe and couplings shall be legibly and permanently marked in ink with the following minimum information:

1. Pipe:
 - a. Nominal size (for example, 4")
 - b. PVC
 - c. Dimension ratio (for example, DR18)
 - d. AWWA pressure class (for example, PC 235)
 - e. ANSI/AWWA C900-07 (or latest edition)
 - f. Manufacturer's name or trademark and production record code.
 - g. Seal (mark) of the testing agency verifying the suitability of the pipe material for potable water service.

- h. Seal (mark) of the certifying agencies that have tested and approved the pipe for use in fire protection systems.

2. Couplings:

- a. Nominal size (for example, 4")
- b. PVC
- c. AWWA pressure class (for example, PC 305)
- d. ANSI/AWWA C900-07 (or latest edition)
- e. Manufacturer's name or trademark
- f. Seal (mark) of the testing agency verifying the suitability of the pipe material for potable water service.
- g. Seal (mark) of the certifying agencies which have tested and approved the pipe for use in fire protection.

2.03 HDPE PIPE, JOINTS AND FITTINGS

- A. The pipe supplied under this section shall be high performance, high molecular weight, and high density polyethylene (HDPE) pipe. Minimum cell classification values of the pipe material shall be (345464E) as referenced in ASTM D3350. The pipe shall have minimum dimension ratio DR 9 and pressure class 200. The fittings supplied under this specification shall be molded from a polyethylene compound having a cell classification equal to or exceeding the cell classification of the pipe supplied under this specification. Pipe shall meet the applicable requirements of ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-PR) based on Outside Diameter and AWWA C906.
- B. Upon meeting the above referenced dimension ratio and pressure class, the required inside diameter of HDPE pipe shall be at least the same as the required inside diameter of corresponding PVC pipe (i.e. 8" HDPE has the equivalent ID of 6" PVC, 10" HDPE has the equivalent ID of 8" PVC, 12" HDPE has the equivalent ID of 10" PVC).

C. Physical Properties of Pipe and Pipe Compound

1. Density - The density shall be 0.941-0.957 gms/cm when, tested in accordance with ASTM D1505.
2. Melt Flow - Melt Flow shall be no greater than 0.11 gms/10 min. When tested in accordance with ASTM D1238 - Condition E.
3. Flex Modulus - Flex Modulus shall be greater than 110,000 psi when tested in accordance with ASTM D790.
4. Tensile Strength at Yield - Tensile strength at yield shall be greater 3,200 psi when tested in accordance with ASTM D638.
5. ECSR Environmental Stress Crack Resistance shall be in excess of 5,000 hours with zero failures when tested in accordance with ASTM D1693 Condition C.
6. Hydrostatic Design Basic shall be 1,600 psi at 23° C when tested in accordance with ASTM D2837.

D. Pipe shall be made of virgin materials. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant for resin of the same specification from the same raw material pipe.

E. Fittings

1. All molded fittings and fabricated fittings shall be fully pressure rated to match the pipe SDR pressure rating to which they are made. All fittings shall be molded or fabricated by the manufacturer. No Contractor fabricated fittings shall be used unless approved by the Engineer.

2. The manufacturer of the HDPE pipe shall supply all HDPE fittings and accessories as well as any adapters and/or specials required to perform the work as shown on the Drawings and specified herein.
3. All fittings shall be installed using butt fused fittings, thermofused fittings/couplings, or flanged adapters and must be approved by the Engineer. NO size on size wet taps shall be permitted.
4. All transition from HDPE pipe to ductile iron or PVC shall be made per the approval of Engineer and per the HDPE pipe manufacturer's recommendations and specifications. Unless otherwise directed by the Engineer, pipe of dissimilar materials shall be connected with stainless steel shielded sewer couplings. Gaskets shall meet ASTM C1173-91, 300 Series stainless steel shear ring with a minimum thickness of 0.012", 316 grade stainless steel nut and bolt tightening clamps, shear ring and clamps to meet all requirements of ASTM A167. Transitional sizes shall utilize a one piece gasket. Stainless steel sewer coupling shall be manufactured by Mission Rubber Company MR Series, Fernco Inc. RC Series, or Engineer-approved equivalent.

F. Pipe and Fittings Markings:

1. The following shall be continuously indent printed on the pipe or spaced at intervals not exceeding 5 feet: name and/or trademark of the pipe manufacturer; nominal pipe size; dimension ratio; the letters PE followed by the polyethylene grade in accordance with ASTM D1248 followed by the hydrostatic design basis of psi (e.g., PE 3408); manufacturing standard reference (e.g., ASTM F714 and AWWA C906); and a production code from which the date and place of manufacture can be determined.

2. Fittings shall be marked with the manufacturer's name (or trade mark), the designation ASTM D3350 and ASTM F714 and AWWA C906, and the manufacturer's code identifying the resin manufacturer, lot number and date of manufacture.
- G. Pipe and Fittings shall be homogeneous throughout and free of: serious abrasion, cutting, or gouging of the outside surface extending to more than 10 percent of the minimum wall thickness in depth; cracks; kinking (generally due to excessive or abrupt bending); flattening; holes; blisters; and other injurious defects. They shall be uniform as commercially practical in color, opacity, density, and other physical properties. Any pipe and fittings not meeting these criteria shall be rejected.
- H. All HDPE pipe shall be black in color with green permanent stripes extruded into the outer pipe length (purple for reclaimed water, blue for potable water). All pipe and fittings shall be from the same manufacturer and different colored striped pipes shall not be intermixed.
- I. Joints:
1. Pipe lengths shall be assembled in the field with butt-fused joints in accordance with ASTM D2657 and the pipe manufacturer's written instructions shall apply. Joint strength shall be equal to or greater than the tensile strength of the pipe and shall indicate a ductile rather than brittle fracture when tested.
 2. Joint with Fusion Equipment: The fusion machine shall have hydraulic pressure control for fusing two pipe ends together and shall be equipped with gauges to monitor fusion pressures. The machine shall be equipped with an electric or gasoline engine powered facing unit to square and trim the pipe ends smooth and provide full surface contact with the heating plate. The heating plate on the fusion machine shall be

electrically heated and thermostatically controlled with a temperature gauge and be capable of maintaining 500°F with a tolerance of 10°F. Fusion temperature shall be as recommended by the pipe manufacturer. The heater plate shall be equipped with suitable means to measure the temperature of plate surfaces and to assure uniform heating such as thermometers or pyrometers.

3. Where excavations for pipe installation are made between manholes, the pipe shall be joined by butt-fusion or per manufacturer's recommendations.
 4. After the fusion process has been completed, internal beads and all excess HDPE materials near pipe joints shall be removed using an internal bead remover for the purpose of reestablishing a smooth internal pipe wall. The internal bead remover shall be manufactured by R & L Manufacturing, Inc., McElroy Manufacturing Inc., or an equal approved by the Engineer before the date of bid opening.
 5. A factory qualified joining technician as designated by the pipe manufacturer shall perform all heat fusion joints.
- J. The finished HDPE pipe shall be continuous over the entire length of run between two manholes and shall be free from visual defects.
- K. Certification: Submit certified lab data or manufacturer's written certifications to verify the physical properties of the materials supplied under this specification.
- L. Rejection: Polyethylene pipe and fittings may be rejected for failure to meet any of the requirements of this specification.
- M. Pipe Dimension: Pipe supplied under this specification shall have an actual inside diameter not less than the diameters of pipe shown in the Contract Documents.

N. Construction Practices:

1. Repair of Damaged Sections: Segments of pipe having cuts or gouges on the exterior of the pipe in excess of 10% of the minimum wall thickness of the pipe shall be cut out and removed or that section of pipe will be rejected. The undamaged portions of the pipe shall be rejoined using the butt fusion joining method.
2. Pipe Joining: Sections of polyethylene pipe should be joined into continuous lengths on the job site above ground. The joining method shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedure shall be capable of meeting all conditions, alignment, and fusion pressure. Pipe lengths to be joined by thermal butt-fusion shall be of the same type, grade, and class of polyethylene compound and supplied from the same raw material supplier.
3. Handling of Fused Pipe: Fused segments of pipe shall be handled so as to avoid damage to the pipe. When lifting fused sections of pipe, chains or cable type chokers should be avoided. Nylon slings are preferred. Care should be exercised to avoid cutting or gouging the pipe.
4. The pipe fusion machine shall have the following minimum design features:
 - a. Guide rods shall be in a plane that passes through the centerline of the pipe thus canceling the bending forces in the machine caused by the fusion forces.
 - b. The clamp shall be mechanically or hydraulically operated and have the strength to "round up" the pipe close to the fused joint and clamp each piece of pipe on continuing straight

centerline. The jaws shall be designed for quick installation and removal of inserts for smaller pipe sizes.

- c. The heater-plate shall be electrically heated, and thermostatically temperature controlled. The surface shall be smooth with a high quality Ryton coating. The machine shall be capable of maintaining the surface temperature set at the pipe manufacturer's recommended temperature range. The heater plate shall be equipped with an indicating thermometer but surface temperatures should be checked with a pyrometer occasionally. The heater surface shall be kept clean and free from plastic accumulation.
- d. The hydraulically operated machines shall have a pressure regulator to preset the correct pressure for the desired fusion force, and there shall be an auxiliary system to control "feed" rate for the pipe face-off. Each machine shall be permanently equipped with a chart showing correct fusion pressure for each pipe size and wall thickness (DR).

2.04 EQUIPMENT

A. General

- 1. As a minimum, the directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pullback the sewer pipe, a drilling fluid mixing, delivery and recovery system of sufficient capacity to successfully complete the bore, a guidance system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume, personnel meeting the training requirements, and all other equipment required to complete the installation. The

Contractor has the option of using a drilling fluid recycling system capable of removing solids from the drilling fluid so that the fluid can be re-used.

2. Prior to delivery to the site, all drilling equipment shall be serviced, inspected for damage and repaired as necessary. The equipment shall be in good, safe operating condition.

B. Drilling System

1. Drilling Rig: The directional drilling machine shall consist of a hydraulically powered system to rotate, push, and pull hollow drive pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the bore. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pull-back pressure during pull-back operations. The Contractor shall record this information and provide a copy to the Engineer. The rig shall be grounded during drilling and pull-back operations. There shall be a system to detect electrical current from the drilling string and an audible alarm which automatically sounds when an electrical current is detected.
2. Drill Head: The drill head shall be steerable by changing its rotation and shall provide the necessary cutting surfaces and drilling fluid jets.
3. Mud or Mechanical Motors (if required): Mud or Mechanical motors shall be of adequate power to turn the required drilling tools.

4. Drill Pipe: Shall be constructed of high quality 4130 seamless tubing, grade D or better, with a threaded box and pins. Tool joints should be hardened to 32-36 RC. If the Contractor chooses another type of drill pipe, the Contractor shall supply to the Engineer the reason for change along with drilling rig manufacturer's approval.

C. Guidance System

1. A magnetic guidance system (MGS), grade beacon or proven gyroscopic system shall be used to provide a continuous and accurate determination of the location of the drill head during the drilling operation. The directional drilling guidance system shall have the capability of measuring vertical and horizontal positions and roll. The system shall obtain an accuracy range within one-inch of the actual position of the drilling head. It shall enable the driller to guide the drill head by providing immediate information on the tool face, azimuth (horizontal direction) and inclination (vertical direction).
2. The Contractor shall compute the position in the X, Y, and Z axis relative to the ground surface a minimum of every 1 foot. Ground surface elevation shall be based on surveyed field conditions.
3. The guidance system shall be of a proven type and shall be operated by personnel trained and experienced with the system.
4. The Contractor shall demonstrate a viable method to eliminate error. Contractor shall submit calibration results showing that the equipment is within tolerance. The Contractor shall follow the manufacturer's recommended calibration sequence and calibration time schedule.

5. The guidance system shall be capable of generating a plot of the bore hole survey for the purpose of an as-built drawing.
6. Contractor shall use a locating and tracking system capable of ensuring that the proposed horizontal and vertical alignment is installed as intended.

D. Drilling Fluid System:

1. Mixing System: A self contained, closed, drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid. Mixing system shall continually agitate the drilling fluid during drilling operations.
2. Drilling Fluid: The Contractor shall use a drilling fluid suitable for the soil conditions as they exist for the project. The Contractor shall fully determine the soil conditions prior to fluid selection (be it from additional geotechnical investigation, exposing utilities, digging a slurry catch pit or other method). This decision shall include product concentrations and additives.
3. Delivery System: The drilling fluid pumping system shall have a capacity to provide an adequate flow rate and pressure to facilitate the HDD operation as defined in the construction documents. The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be leak-free. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and conveyed to the drilling fluid recycling system (if used). A berm, minimum of 12" high, shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits, and drilling fluid recycling system to prevent spills into the surrounding environment. Pumps and or

vacuum trucks of sufficient size shall be in place to convey excess drilling fluid from containment areas to storage and recycling facilities.

4. Drilling Fluid Recycling System: If the Contractor chooses to use a drilling fluid recycling system, the system shall separate sand, dirt and other solids from the drilling fluid to render the drilling fluid re-usable. Spoils separated from the drilling fluid will be stored in a suitable location, as approved by the Engineer, for later use or disposal.

2.03 OTHER EQUIPMENT

A. PIPE ROLLERS

Pipe rollers, if required, shall be of sufficient size to fully support the weight of the pipe while being hydro tested and during pullback operations. Sufficient number of rollers shall used to prevent excess sagging of pipe. The pipe shall not be dragged across the surface.

B. PULLBACK

Contractor shall use breakaway swivel or mechanical "weak link" to prevent overstressing of the pipe.

C. PIPE RAMMERS

Hydraulic or pneumatic pipe rammers may only be used if necessary and with the authorization of Engineer.

D. RESTRICTIONS

Other devices or utility placement systems for providing horizontal thrust other than those previously defined in the preceding sections shall not be used unless approved by the Engineer prior to commencement of the work. Consideration for approval will be made on an individual basis

for each specified location. The proposed device or system will be evaluated prior to approval or rejection on its potential ability to complete the utility placement satisfactorily without undue stoppage and to maintain line and grade within the tolerances prescribed by the particular conditions of the project.

PART 3 OPERATIONS

3.01 GENERAL

- A. The Engineer must be notified 48 hours in advance of starting work. The Directional Drilling shall not begin until the Engineer is present at the job site and agrees that proper preparations for the operation have been made. The Engineer approval for beginning the installation shall in no way relieve the Contractor of the ultimate responsibility for the satisfactory completion of the work as authorized under the Contract. It shall be the responsibility of Engineer to provide inspection personnel at such times as appropriate without causing undue hardship by reason of delay to the Contractor.
- B. Installation Tolerance
 - 1. Tolerance requirements for the installed pipe are performance orientated. Tolerances specified herein are the minimum requirements. **It is the sole responsibility of the Contractor to select the appropriate types of equipment, work methods and procedures to meet the tolerance requirements.**
 - 2. For gravity installations it is essential that minimal to no changes in pipe slope occur and that a downward slope be maintained throughout the entire length of pipe. The tie-in elevations shown for the beginning and ending of the HDD work of the project must meet the elevations shown on the plans. The ends of the pipe shall be located (horizontally and vertically) such that the directional drilled pipe installed

according to this specification can be tied to other segments of sewer line without negative slopes or sags.

3. The Engineer reserves the right to reject pipes installed not meeting the tolerance requirements specified herein. It will be the responsibility of the Contractor to replace rejected work with pipe meeting these requirements. No additional compensation shall be provided to the Contractor for replacement of pipe not meeting tolerance requirements.
- C. It is the responsibility of the Contractor to implement means and procedures compatible with anticipated ground conditions. The Contractor shall have a representative who is thoroughly knowledgeable of the equipment and HDD procedures present at the job site during the entire installation and available to address immediate concerns and emergency operations.
- D. The Engineer must be notified immediately if any condition is encountered that stops the forward progress of drilling operations. When it is determined that it is impossible to continue drilling operations, the Contractor shall determine the best course of action. The Contractor may be allowed to abandon the completed portion in place and start a new hole as directed by the Engineer at no additional cost to the County.
- E. Contractor shall take responsibility for the restoration of any damage caused by heaving, settlement, separation of pavement, escaping drilling fluid, or the directional drilling operation, at no cost to the County.
- F. The installation of the sewer pipe into the bore hole shall be on the same day that the bore is completed to ensure the necessary support exists.
- G. The required piping shall be assembled in a manner that minimizes the obstruction of adjacent roadways, driveways or public activities. The

Contractor shall erect temporary fencing around entry and exit pipes staging areas as needed. The Contractor staging areas shall be as approved by the Engineer.

- H. Permits: The Contractor is responsible for obtaining all necessary permits. Copies of each permit shall be available to the Engineer at the work site.

3.02 PERSONNEL REQUIREMENTS

- A. All personnel shall be fully trained in their respective duties as part of the directional drilling crew and in safety.

3.03 DRILLING PROCEDURE

A. SITE PREPARATION

Work site as indicated on drawings, within right-of-way, shall be graded or filled to provide a level working area. No alterations beyond what is required for operations are to be made. Contractor shall confine all activities to designated work areas.

B. ENVIRONMENTAL PROTECTION

Contractor shall place silt fence between all drilling operations and any drainage, wetland, waterway or other area designated for such protection by contract documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. Contractor shall adhere to all applicable environmental regulations. Fuel or oil may not be stored in bulk containers within 200' of any water body or wetland.

C. SAFETY

Contractor shall adhere to all applicable state, federal and local safety regulations and all operations shall be conducted in a safe manner. Safety meetings shall be conducted at least weekly with a written record of attendance and topic submitted to Engineer.

D. PILOT HOLE

1. The Contractor shall follow the pipeline alignment as shown on the Drawings, within the specified tolerances. If adjustments are required, the Contractor shall notify the Engineer for approval prior to making the adjustments.
2. In the event of difficulties at any time during HDD operations requiring the complete withdrawal from the bore, the Contractor may be allowed to withdraw and abandon the bore and begin a second attempt at a location approved by the Engineer.
3. In the event that a drilling fluid fracture, inadvertent returns or returns loss occurs during pilot hole drilling operations, contractor shall cease drilling, wait at least 30 minutes, inject a quantity of drilling fluid with a viscosity exceeding 120 seconds as measured by a March funnel and then wait another 30 minutes. If mud fracture or returns loss continues, contractor will cease operations and notify Engineer. Engineer and contractor will discuss additional options and work will then proceed accordingly.
4. Establish an entry angle hole so that the curvature of the pilot hole does not exceed the allowable bending radius of the pipe.

5. Sags in the sewer pipe shall not exceed 10% of nominal pipe diameter. Sags will only be allowed where the entering and exiting grades are adequate to provide velocities through the sag area sufficient for moving solids. No more than one sag area shall occur between two manholes. The Engineer must approve the alignment of the bore before pipe can be pulled. If the pilot bore fails to conform to the above tolerances, the Engineer may require a new pilot boring be made.
6. At completion of the pilot hole drilling, provide Engineer tabulations of the horizontal and vertical alignment at minimum, intervals of 10 feet.

E. PIPE INSTALLATION

1. Horizontally directional drilled pipe shall be installed in accordance with the instruction of the manufacturer, as shown on the Drawings and as specified herein.
2. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before installation, and no piece shall be installed which is found to be defective. Any damage to the pipe shall be repaired as directed by the Engineer. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner by the contractor, at his own expense.
3. Ropes, fabric or rubber protected slings and straps shall be used when handling pipes. Chains, cables or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe.

4. After the pilot hole is completed, the Contractor shall enlarge the hole by pre-reaming (as needed), and install a swivel to the reamer and commence pullback operations.
5. Contractor will ream bore hole to a minimum size necessary to safely and properly install the pipe. The annular space on the final bore hole shall not exceed 3-inches measured from the outside diameter of the host pipe.
6. The pipe being pulled into the bore shall be protected and supported by rollers so that it moves freely and is not damaged by debris on the ground during installation. The pipe may not be dragged across the ground surface.
7. Pullback forces shall not exceed the allowable pulling forces for the product pipe. The thickness of the pipe shall be increased by Contractor at their cost if pullback forces are anticipated to exceed the allowable pulling force on the specified pipe.
8. The Contractor shall allow sufficient lengths of pipe to extend past the termination point (4" minimum) to allow connections to adjacent pipe sections or manholes. Pulled pipe shall be allowed 12 hours of stabilization prior making tie-ins. The length of extra product pipe shall be at the Contractor's discretion.

F. DRILLING FLUID:

1. Disposal of excess drilling fluid and spoils will be the responsibility of the Contractor who shall comply with all relevant regulations, right-of-way, work space, and permit agreements. Excess drilling fluid and spoils shall be disposed of properly. The Contractor is responsible for transporting all excess drilling fluid and spoils to the

disposal site and paying any disposal costs. Excess drilling fluid and spoils shall be transported in a manner that prevents accidental spillage onto roadways. Excess drilling fluid and spoils shall not be discharged into sanitary or storm systems, ditches or waterways.

2. Drilling fluid returns (caused by fracturing of formations) at locations other than the entry and exit points shall be minimized. The Contractor shall immediately clean up any drilling fluid that inadvertently surfaces.
3. The Contractor shall be responsible for all fees and provisions for a clean water supply for mixing of drilling fluid.

3.04 TESTING

- A. All invert elevations shall be surveyed by a professional surveyor and checked to proposed plan grade before making any connections to the directionally drilled pipe.
- B. Each horizontally directionally drilled sewer reach shall have an approved amount of water (as determined by the SCSE) poured down the upstream invert after completion and then videotaped for approval.
- C. Air testing shall be conducted as the project is being installed. This includes all mainline sewer between manholes, future mainline stubs and laterals out of manholes. The air testing shall be in accordance with ASTM F1417.
- D. Deflection testing shall be required as specified in Appendix 'C'.

3.05 CLEANING, SITE RESTORATION, AND INSPECTION

- A. Following drilling operations, contractor will demobilize equipment and restore the worksite to original condition. All excavations will be backfilled and compacted to 95% of original

density. Landscaping will be restored to original. All mud shall be disposed of by the Contractor.

- B. The Contractor is required to maintain the work site in a neat and orderly condition throughout the period of work and after completing the work at each site, remove debris, surplus material and temporary structures erected by the Contractor. Upon completion of work, the site must be restored to its former condition.
- C. Upon installation, the Contractor shall clean and televise the pipe per Item 40.

3.06 RECORD KEEPING

A. AS-BUILTS

Contractor shall maintain a daily project log of drilling operations and a guidance system log with a copy given to Engineer at completion of project. As-built drawings shall be certified as to accuracy by the Engineer.

3.07 MEASUREMENT AND PAYMENT

- A. The unit price stipulated per linear foot for the various sizes of HDD pipe sewer shall include earth excavation and backfill, restoration, and the furnishing of all labor, materials, tools, and appliances necessary to complete the work as specified, shown or directed. No additional payment will be made.
- B. The lengths of HDD sewer pipe to be paid for under this Item shall be the total number of linear feet of each size actually furnished and placed in accordance with the Specifications, measured along the axis of the pipe after the pipe has been connected in place. The inside diameter of manholes and the length of special structures will be deducted.

END OF SECTION